UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:

SR-6J

August 27, 1996

Mr. Al Howard
Chief Executive Section
Environmental Response Division
Michigan Department of Environmental Quality
P.O. Box 30473
Lansing, Michigan 48909

Re: Gratiot County Landfill, St. Louis, Michigan
Five-Year Review Report

Dear Mr. Howard:

The U. S. Environmental Protection Agency (U. S. EPA) has reviewed the Five-Year Review Report dated July 9, 1996, developed by the Michigan Department of Environmental Quality for the subject site. The report is hereby approved.

U. S. EPA appreciates the efforts of Kim Sakowski and Marjorie Frisch of your staff in conducting this review. Please feel free to contact me if you have any questions.

Sincerely,

William E. Muno, Director
Superfund Division

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FIVE-YEAR REVIEW REPORT

GRATIOT COUNTY LANDFILL

ST. LOUIS, MICHIGAN

Prepared by:

Michigan Department of Environmental Quality
Lansing, Michigan

July 9, 1996

FIVE YEAR REVIEW REPORT
GRATIOT COUNTY LANDFILL

I. PURPOSE

The Michigan Department of Environmental Quality (MDEQ) has conducted a five-year review of the Gratiot County Landfill Superfund site, located in St. Louis, Michigan. This review was intended to evaluate whether the remedial action (RA) remains protective of public health and the environment.

Section 121(c) of the Comprehensive Environmental Response, Compensation and Liability Act requires that periodic reviews (at least once every five years), be conducted for sites where hazardous substances, pollutants or contaminants remain at the site after initiation of remedial actions for the site. The purpose of such a review is to determine the continued adequacy of the RAs implemented and to evaluate whether original cleanup levels decided upon remain protective of human health and the environment.

The OSWER Directive 9355.7-02 (Structure and Components of five-year review, May 23, 1991), provides that the U. S. Environmental Protection Agency (EPA) will conduct five-year reviews as a matter of policy at; 1) sites where no hazardous substances will remain above levels that allow unlimited use and unrestricted exposure after completion of the RA, but the cleanup levels specified in the Record of Decision will require five or more years to attain; or 2) sites addressed pre-Superfund Amendments and Reauthorization Act of 1986 at which the remedy, upon attainment of the cleanup levels, will not allow unlimited use and unrestricted exposure. The five-year review of the Gratiot County Landfill Superfund site was conducted in accordance with this policy.

The EPA has established a three-tier approach to conducting five-year reviews, the most basic of which provides a minimum protectiveness evaluation (Level 1 review). The EPA contemplates that a Level I review will be appropriate in all but a relatively few cases where site-specific circumstances suggest otherwise. The second and third levels (Level II and Level III) of a review are intended to provide the flexibility to respond to varying site-specific considerations, employing further analysis. Site-specific considerations, including the nature of the RA, the status of on-site response activities, and the proximity to populated areas and sensitive environmental areas determine the level of review for a given site.

II. SITE HISTORY

The Gratiot County Landfill Superfund site is a 40-acre landfill located on an 80-acre parcel of land at 7391 Croswell Road (formerly 585 East Jackson Road), St. Louis, Michigan.

(Figure 1)

The Gratiot County Landfill was licensed in 1971 by the Gratiot County Board of Public Works and received domestic, commercial and industrial solid wastes. The Michigan Department of Natural Resources (MDNR)[1] licensed the landfill for operation in 1974. The MDNR license was subject to several operating conditions. Because of operating violations in November 1976, the MDNR initiated proceedings to revoke the landfill's license and close the facility. In late 1976, the EPA informed the MDNR that 269,000 pounds of polybrominated biphenyl (PBB) contaminated waste was disposed of at the Gratiot County Landfill from 1971 to 1974 by the Michigan Chemical Company (Velsicol).

The PBB became widely known in 1973 when livestock feed was accidentally contaminated with BP-6 (PBB), a flame retardant known as Firemaster. Firemaster was manufactured by Velsicol at its St. Louis, Michigan facility. Velsicol also manufactured Nutrimaster, a magnesium oxide-based livestock feed additive. Millions of Michigan's livestock were contaminated by the PBB-laden livestock feed, leading to their destruction. Tons of eggs, milk, butter, cheese, feed and meat were also destroyed. This incident is considered the most costly and disastrous accidental contamination to have occurred in the United States agricultural history and is estimated to have exposed 90 percent of Michigan's residents to PBB contamination.

An MDNR inspection of the Gratiot County Landfill in March 1977, identified stockpiles of magnesium oxide with no surface cover along the western boundary of the landfill. The landfill operator said the material came from Velsicol and was deposited on the landfill property between 1975 and 1977. The MDNR's analysis of the material indicated that the material contained 1 to 2 parts per million PBB. Additional MDNR inspections during the same period revealed more operating violations.

The MDNR initiated an extensive sampling program including sampling of groundwater, surface water and soils of the landfill and surrounding area. PBB was detected in groundwater, surface water and soils on the landfill property and vicinity.

III. SUMMARY AND RESULTS OF INVESTIGATIONS

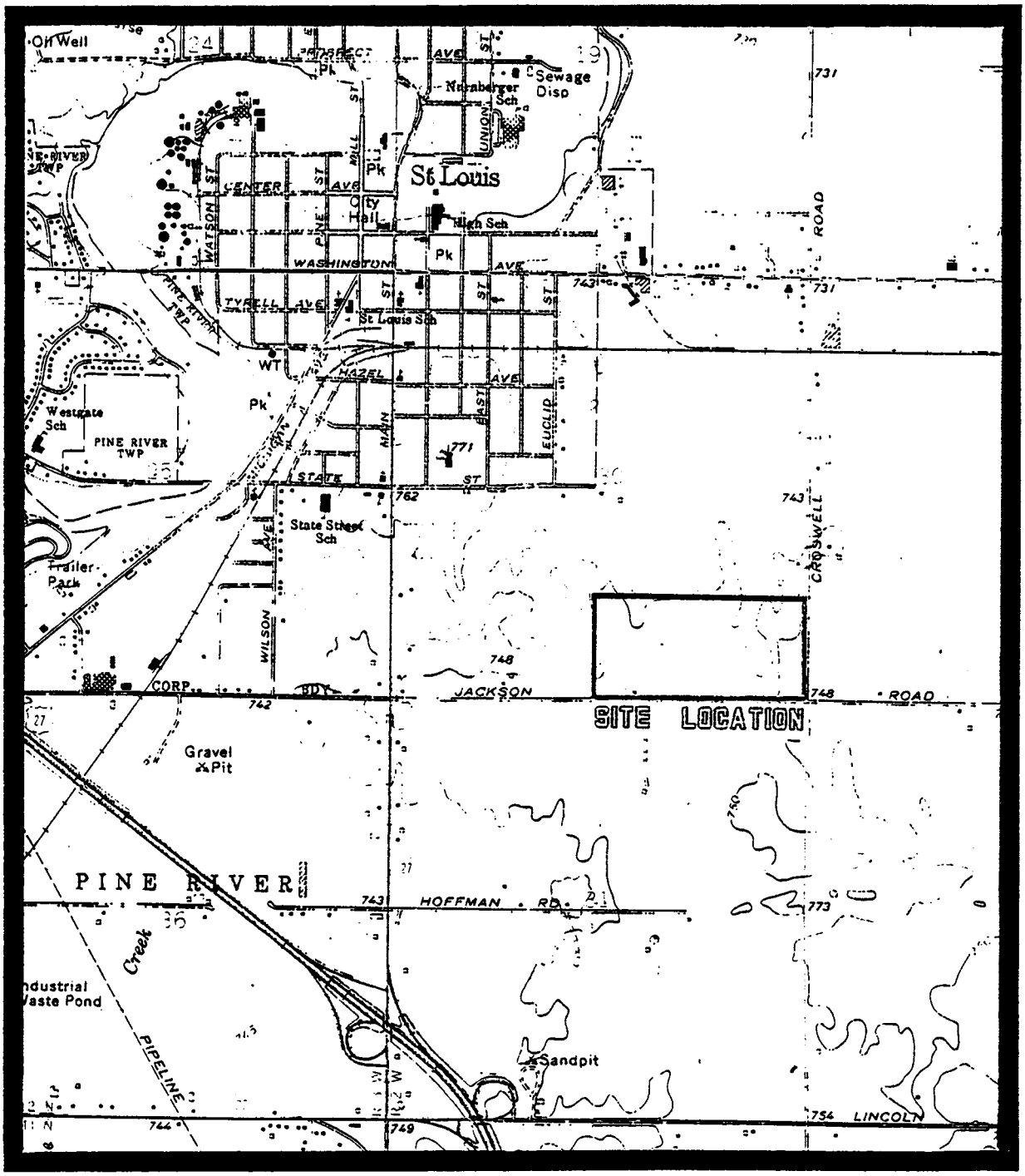
The MDNR completed an initial investigation in 1970, which evaluated the suitability of the site for landfill construction. Nine soil borings were completed, but no monitoring wells were installed during the investigation. The results of the investigation provided operational guidelines for the landfill.

The MDNR and Keck Consulting Service, Inc. (Keck) completed a Phase I Hydrogeologic Investigation in 1977 at the Gratiot County Landfill. The investigation included soil borings and monitoring well installation. Traces of PBB and elevated levels of other contaminants were detected in the shallow groundwater aquifer near the site. The site investigation revealed complex hydrogeologic and subsurface conditions warranting a more detailed hydrogeologic investigation.

[1] The Michigan Department of Natural Resources became the Michigan Department of Environmental Quality in October 1995.

GRATIOT COUNTY LANDFILL

GRATIOT COUNTY, MICHIGAN



SCALE 1"=2000'

U.S.G.S. 7.5 MINUTE QUADRANGLE
ST. LOUIS, MICHIGAN

LOCATION MAP

The MDNR conducted a Phase II Hydrogeologic Study in 1978. Soil and groundwater conditions at and near the landfill were characterized by 155 soil borings and 45 monitoring wells completed by Keck and Hart Well Drilling. The Phase I and Phase II studies identified four stratigraphic units and three aquifer systems near the landfill.

Reports based on previously obtained information were completed in 1978, 1979 and 1980. These reports included: “Feasibility Study of Control Measures for the Containment of PBB and Other Contaminants at the Gratiot County Landfill”, Hazra Engineering Company, 1978; “Hydrogeologic Investigation and Engineering Alternatives for Control Measures”, Resource Recovery Division, MDNR, 1979; and “Environmental Impact Assessment for Gratiot County Landfill Remedial Action”, Resource Recovery Division, MDNR, 1980.

A Phase III Hydrogeologic Investigation conducted by Keck was completed in 1980. Two monitoring wells and a pumping well were installed as part of this study. The investigation summarized aquifer characteristics and pumping test data.

The MDNR initiated remedial activities at the Gratiot County Landfill in 1984. The first phase of the remedial activities included the containment of groundwater and the prevention of contaminant migration. This phase also included the following: completing 27 soil borings; installing an 8-inch diameter pumping well; constructing a slurry wall around the landfill perimeter; constructing burial cells for the disposal of PBB-laden waste located on the property across from he landfill on Jackson Road; installing a fence around the landfill; capping the landfill with a 5-foot thick compacted clay layer; constructing a concrete wastewater lagoon; and installing an evapotranspiration bed to dispose of water from landfill purge wells used for long-term water level control.

The second phase of remedial activities included a Groundwater Purge System Design Phase I Investigation of the landfill completed by E.C. Jordan in June 1986. The investigation consisted of installing three monitoring wells within the landfill refuse, installing one monitoring well and a pumping well in the local aquifer, and collecting Shelby tube samples from the slurry wall. The second phase of the Groundwater Purge System Design Phase II Investigation for the landfill consisting of a purge system construction was never completed.

E.C. Jordan submitted a technical memorandum in August 1986 to the MDNR providing: computer data plots and tables summarizing groundwater quality (March 1977 to February 1986) and elevations (May 1986); and a quantitative assessment of on-site groundwater trends related to the slurry wall and cap emplacement. E.C. Jordan indicated in the memorandum that groundwater quality data as of February 1986 showed no significant overall trend as a result of the slurry wall and cap emplacement and their interpretation of potentiometric data suggested that the slurry wall is an effective barrier separating groundwater flow inside the wall from groundwater flow outside the wall.

GZA-Donohue (GZA) provided the MDNR with an evaluation of existing site data and a monitoring scheme, an evaluation of the slurry wall and clay cap effectiveness, and remedial action recommendations for the Gratiot Landfill site in the Hydrogeological Investigation Report, January 1992. GZA performed on-site activities from September 1989 through December 1991. GZA activities included test boring, monitoring well installation, soil headspace testing, geophysical testing, groundwater sampling, surface water sampling, hydraulic conductivity testing, pressure transducer installation, weather station installation, storage lagoon decommissioning, and groundwater elevation monitoring.

GZA evaluated the effectiveness of the slurry wall by comparing groundwater quality, elevation, and flow direction between well pairs set on opposite sides of the slurry wall. Three areas of the slurry wall were identified by GZA as ineffective in preventing groundwater flow. These areas are the southern portion of the east wall, the western portion of the south wall, and the southern portion of the west wall. Volatile organic compounds (VOCs) were detected in samples from monitoring wells G12-D and G16-D, which are on opposite sides of the southern portion of the west slurry wall (Figure 2). Detectable VOCs included chloroethane, 1,1-dichloroethane, and 1,2-dichloroethane, ranging from 10 to 30 ug/L. Benzene was detected in wells G13-D and G16-D at concentrations of 44 and 300 micrograms per liter (ug/L), respectively. GZA evaluated two alternatives to minimize groundwater flux through the landfill in a document dated August 4, 1992. These two remedial alternatives were repair of the slurry wall through reconstruction or grouting, and controlling leakage by groundwater pumping.

GZA concluded that the landfill cap was well maintained and provided an effective barrier against surface water infiltration. No cap erosion was observed, and vegetation was characterized as well established and controlled. Surface water ponding was observed in several areas of the site; GZA concluded that the ponding was not a significant threat to the structural integrity of the cap. GZA indicated that gas vent maintenance and repairs may be needed. Observations of gas venting through the ground surface and impacts on vegetation growth were noted in at least one area.

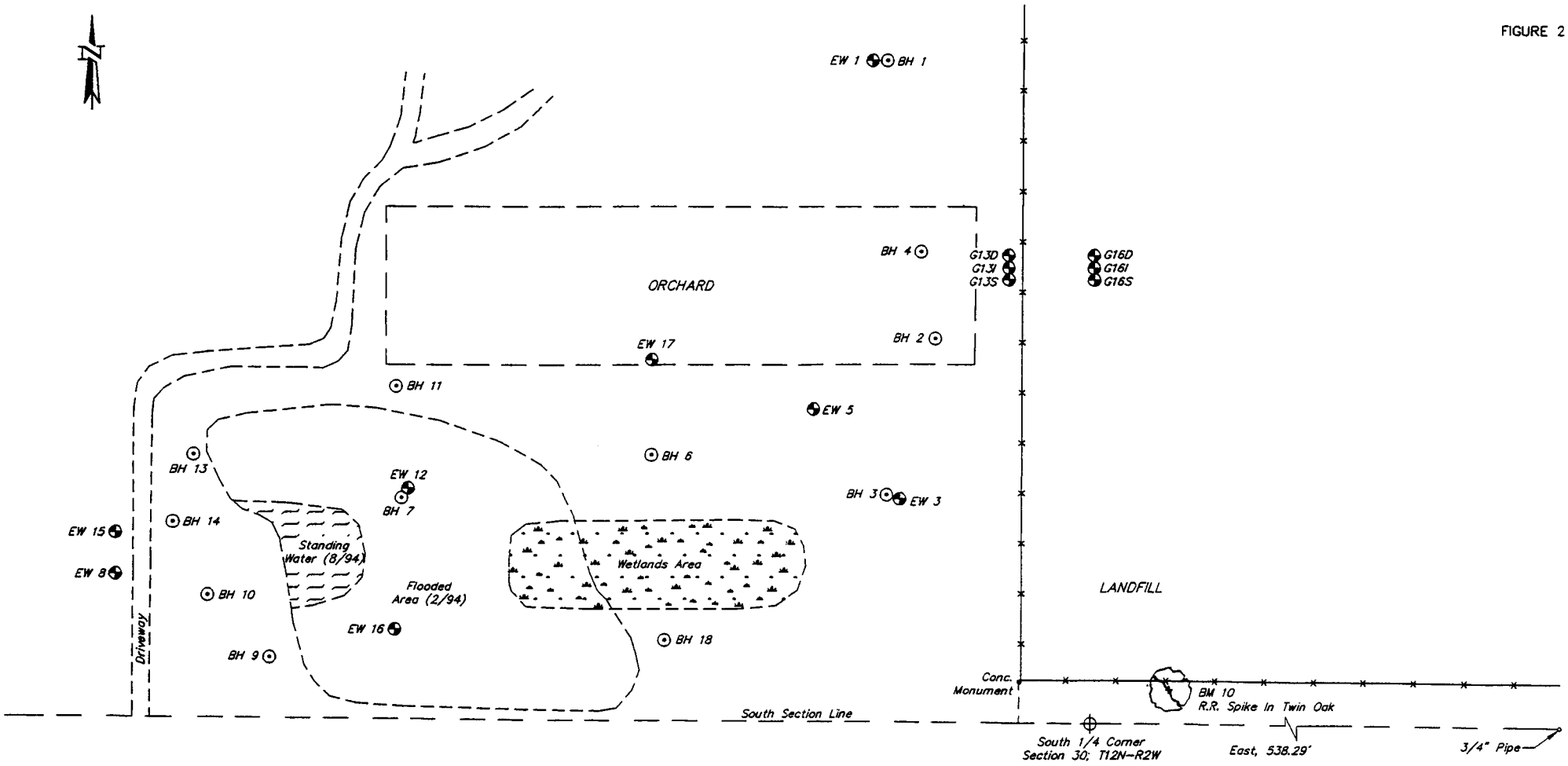
The MDNR retained EDER Associates (EDER) in December 1993, to conduct a Preliminary Environmental Assessment consisting of a groundwater investigation to determine the extent of VOC contamination identified at monitoring well G-13D, located along the southern portion of the west slurry wall. Field activities were conducted in two phases and included the completion of soil borings, vertical groundwater profile borings with field gas chromatograph screening and monitoring well installation and sampling.

During Phase I field activities, thirteen soil borings were drilled to characterize soils outside the southern portion of the west slurry wall. Lateral stepping out was necessary to determine the vertical and horizontal extent of groundwater contamination outside the west/southwest side of the landfill. Eleven vertical groundwater profile borings (EW-1 through BH-11) (Figure 3) were drilled. Phase II included an additional five profile borings (EW-12 through EW-15, and BH18) and two monitoring wells (EW-16 and EW-17) to track the full extent of contamination.

The geologic and hydrogeologic conditions of the Gratiot County Landfill site have been evaluated through numerous investigations. Results of each investigation have provided a progressively better understanding of the complex glacial deposits and hydrogeological conditions existing at the site, with a detailed focus on the west/southwest side of the landfill.

The bedrock geology underlying the Gratiot County Landfill region demonstrates some spatial variability. The youngest bedrock in the Gratiot County area (Central Lower Michigan) is the Jurassic Age Red Beds. The Red Beds are irregular and discontinuous throughout the area. The Red Beds consist of poorly consolidated sands and shales with gypsum beds throughout. Where the Red Beds are discontinuous, bedrock consists of the Pennsylvanian Age Grand

FIGURE 2



LEGEND

- Monitoring Well
- Soil Boring
- Fence Line

0 80

Approximate Scale In Feet

WEST/SOUTHWEST SIDE OF LANDFILL LAYOUT MAP

GRATIOT COUNTY LANDFILL
GRATIOT COUNTY, MICHIGAN

River and Saginaw Formations. Generally, Pennsylvanian Age strata in the Michigan Basin are all grouped into the Saginaw Formation. The formation consists of interbedded sandstone, shale, coal and limestone, all of variable thicknesses. A lenticular sandstone is present at the base of the formation.

The unconsolidated sediments in the Gratiot County region consist of Wisconsin glacial deposits. The Saginaw Lobe of the Wisconsin Glacier advanced and retreated, depositing a series of moraines in central Michigan. The Gratiot County Landfill is on the eastern extreme of the northwest-southeast trending Gladwin Recessional Moraine. Sediments near the landfill consist of glacial till and glaciofluvial deposits. East of the landfill, the morainal deposits change to plainer lake bed deposits.

Groundwater occurs in three systems identified in the glacial deposits of the Gratiot County Landfill area. The lowest aquifer system is below the till clay confining layer and serves as the major regional aquifer. A local aquifer and isolated saturated "perched" zones are above the till clay. The Pennsylvanian-Saginaw Formation serves as the bedrock aquifer in the area, with some wells in the Gratiot County area demonstrating flowing artesian conditions.

The local stratigraphy has generally been described as consisting of three clay units and several sand units. Two of the upper clay units grade together vertically, and the third clay unit refers to a basal till clay layer.

A suspected paleo-river channel was encountered trending west southwest from the southwest corner of the landfill. The narrow nature of the VOC plume supports the theory that a paleo channel exists in the till clay layer below the site. The contamination appears to be migrating in a preferred pathway of sand and gravel within the paleo channel. Till clay topography as well as the sands and gravels above the till appear to be providing a controlled "channel" pathway for the contamination to migrate from the source area.

Post investigation groundwater samples were collected from Phase I & II monitoring wells in August 1994, in conjunction with the biannual monitoring event. Groundwater profile screening results at BH-2, EW-5, BH-6, EW-12, BH-14 and EW-15 revealed benzene at depths of approximately 32 to 77 feet. Benzene appears to be limited to the deepest and most centralized portion of the sand unit within the paleo-river channel deposits which consist of coarse to medium sands and gravel resting directly on top of the till clay surface. At the remaining vertical profile locations and monitoring wells, benzene screening results were non-detect from initial saturation to the top of the till clay layer, where profiling was terminated. Laboratory results for the monitoring revealed the following contaminants in exceedances of the old Michigan Type B criteria:

Benzene
Chloroethane
1,2-DCA
Iron
Arsenic

Historically, there has been some sporadic detections of lead in groundwater in the area. The EPA maximum contaminant level (MCL) of 50 ug/L was the only regulatory action level for lead in Michigan at the time of initial remedial investigations and remedial action implementation at

the landfill. Groundwater lead concentrations have been typically below the former MCL and, therefore, were addressed as background levels.

Landfill gas vent operational status was field evaluated on May 18, 1994. Field evaluation included measurement of pressure across the carbon filter of each vent, measurement of gas concentration at each vent and notation of vegetation condition surrounding each vent.

At gas vent #1, both the upper and lower carbon filter pressure nipples were accessible. At #1, both nipples read at gage atmospheric pressure of zero, explosive gas readings near the vent opening were background, and no visible stress of surrounding vegetation was present. Upper and lower nipples at gas vents #2 through #5 were not accessible, under ground, or under water. Explosive gas readings near the vent openings ranged from background at #4 to near 80 percent of the methane LEL at #3 to greater than 100 percent of the methane LEL at #2 and #5. Distressed vegetation was observed at vents #2, #3 and #5. An area encompassing a 20-foot radius around gas vent #5 was observed to be devoid of vegetation and extremely eroded with gas bubbling through standing water.

On October 27, 1994, B & V Construction with EDER oversight, disassembled each gas vent and replaced the activated charcoal filter packs. While the gas vents were disassembled their subsurface extremities were probed for blockage. Nothing blocking or obstructing the gas vents was observed. The area surrounding vent #5 remained devoid of vegetation although vent #5 was venting at the highest rate and volume relative to the other vents. During gas vent maintenance activities, continuous air monitoring for combustible gas concentration and toxicity were conducted.

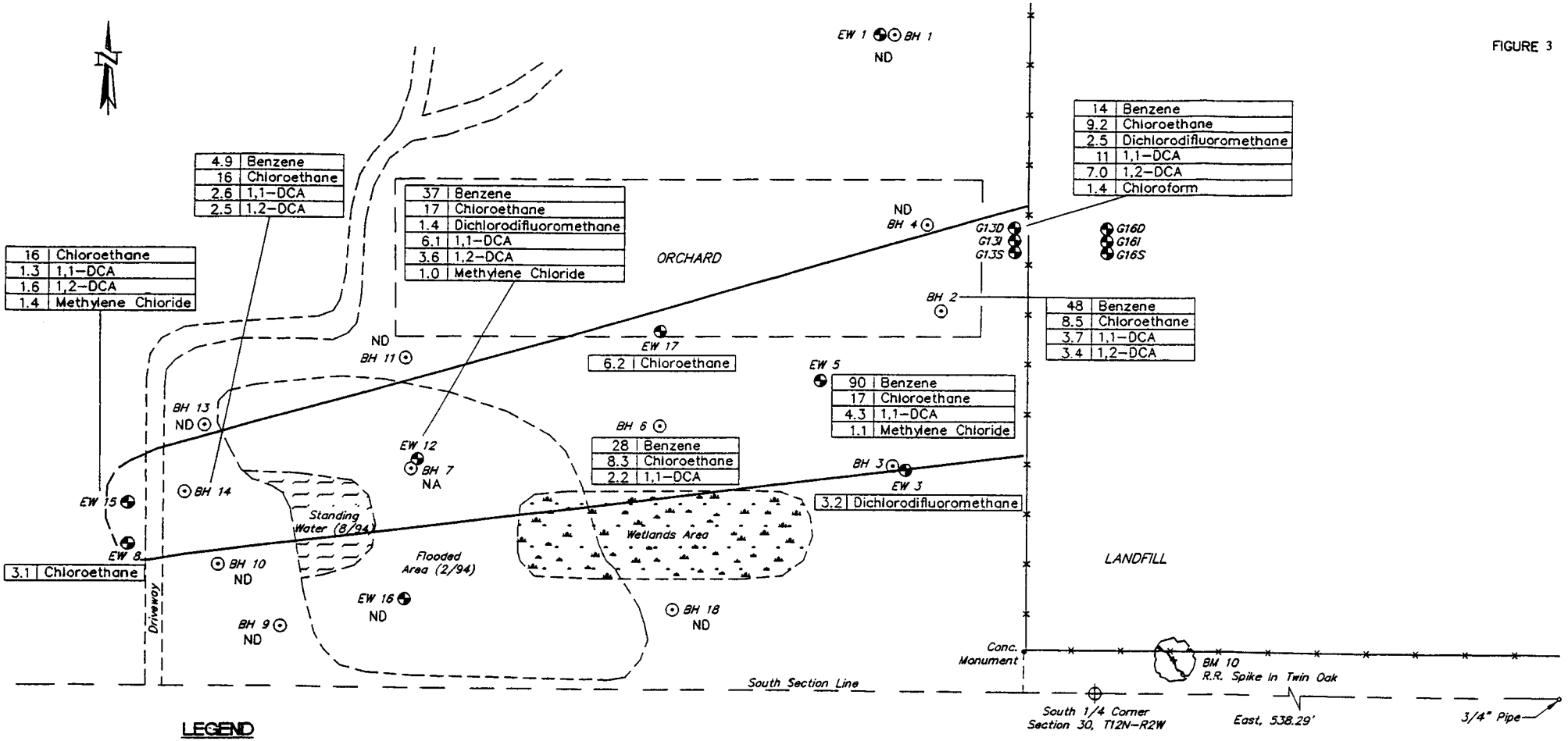
A human health risk assessment and natural environment impact evaluation was completed by the Agency for Toxic Substance and Disease Registry (ATSDR)/Michigan Department of Public Health. The document dated August 29, 1994, was entitled, “Site Review and Update (SRU) for the Gratiot County Landfill Site”(Attachment 1). The purpose of the SRU was not to discuss the status of the hazardous waste site, but to identify future ATSDR activities planned for the site. Conclusions of the Gratiot County Landfill SRU indicate that at this time the landfill site poses no apparent health hazard and there is no apparent need for further health assessment, consultation or study.

IV. CONCLUSIONS

Stratigraphic units encountered during field activities outside the west-southwest of the landfill are consistent with those described during previous site investigations. Three clay units were identified: the upper brown clay vertically grading to a gray clay and the basal till clay. Saturated sands were encountered below the gray clay layer and consisted primarily of medium to coarse sands and gravels confined within a paleo-river channel carved in the underlying till clay surface. This sand unit is referred to as the Local Aquifer.

The limits of the paleo-river channel extend further west/southwest than previously defined. The VOC contamination associated with the landfill leak appears to be primarily in the lower sands (60 to 77 feet below grade) within the narrow paleo-river channel. The leading edge of the contamination extends southwest within the paleo-river channel to monitoring well EW-15.

FIGURE 3



LEGEND

- Monitoring Well
- Soil Boring
- Fence Line
- Approximate Extent Of VOC Contamination
- ND Non Detect
- ND Not Available

NOTE:
Compound Concentrations In ug/L.

0 80
Approximate Scale in Feet

LATERAL EXTENT OF VOC CONTAMINATION

GRATIOT COUNTY LANDFILL
GRATIOT COUNTY, MICHIGAN

Groundwater benzene and chloroethane concentrations are higher at EW-5 than G-13D. This may indicate that the slurry wall leak is at the base of the wall to the south of G-13D, place G-13D at the contaminant plume's northern margin and EW-5 near the plume's center.

Groundwater elevation data measured in August 1994, indicates a groundwater flow direction to the southwest with approximate average flow velocities of 4.5 to 18.25 feet per year, based on hydraulic conductivity's of 10 to 40 feet/day for the lower aquifer sands. A preferred flow path, relatively flat hydraulic gradient, aquifer hetrogeneities, and till clay surface control are contributing to a southwest "channeled" flow within the paleo-channel.

V. SITE VISITS

The MDEQ Project Manager and Geologist make regular visits to the Gratiot County Landfill site. The site visits consist of visual inspection of the site, oversight of contractors performing monitoring and testing on the site and discussions with the landfill caretaker.

VI. RECOMMENDATIONS

Based on the investigations results, the MDEQ recommends continued groundwater quality monitoring . The current monitoring plan includes monitoring interior and exterior landfill well clusters biannually for inorganic general water quality parameters and annually for inorganics and organic parameters.

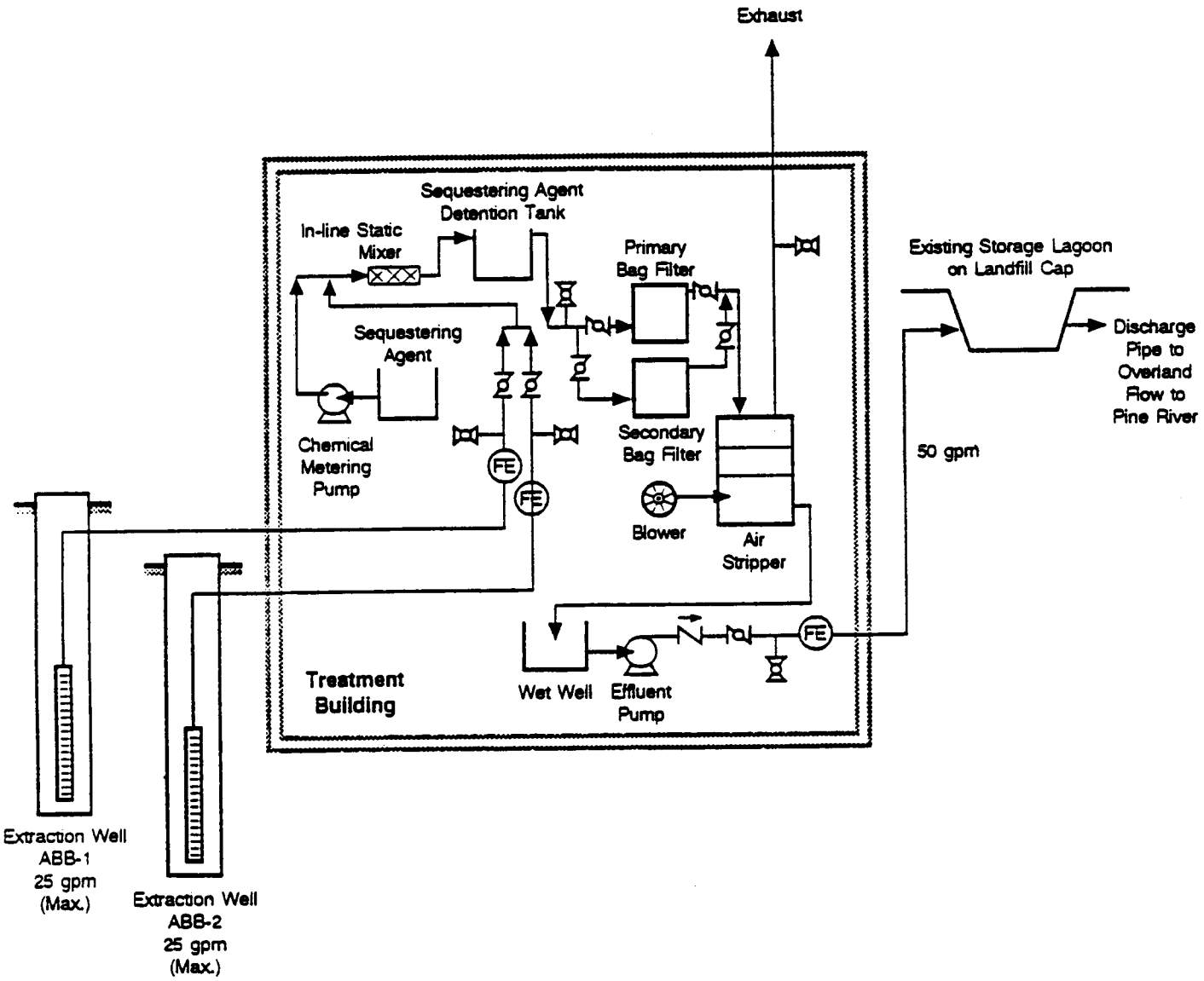
The following cap maintenance procedure is recommended to address the gas venting problem at vent #5. Place a 40-mil very low density polyethylene (VLDPE) geomembrane liner on the denuded area. Anchor the perimeter of the VLDPE liner by placing it in a V-trench at least nine inches deep. Backfill the liner in the trench with sand. Seal the liner around the gas vent pipe by installing a VLDPE pipe boot and gasket. Backfill the liner with a six-inch layer of sand for lateral drainage, a six-inch layer of common earth for erosion control and a minimum three-inch layer of topsoil. Slope the fill away from the gas vent pipe to facilitate surface drainage. Seed to reestablish vegetative growth.

The MDEQ recommends conducting pneumatic slug tests on each of the newly installed monitoring wells outside the west/southwest side of the landfill and also monitoring well G-13D. A pneumatic slug test is a reliable data acquisition method for making hydraulic conductivity estimates in highly transmissive aquifers.

As a corrective action for the remedy, the MDEQ recommends the installation of the groundwater purge and treatment system using an air stripper. (Figure 4)

VII. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Five-year review guidance established policy for the EPA to review and analyze the RA at a site as it is affected by newly promulgated or modified federal and state environmental laws. The ARARs associated with the construction and long-term maintenance and monitoring of the RA at the Gratiot County Landfill were not addressed in the Consent Judgment because the December 1982 Consent Judgment pre-dates establishment and use of ARARs.



LEGEND

- Flow Control/Isolation Value
- Sample Port
- Flow Element
- Check Valve

Not To Scale

FIGURE 4
PROCESS FLOW DIAGRAM
CONCEPTUAL DESIGN
GRATIOT COUNTY LANDFILL
ST. LOUIS, MICHIGAN

The following are a list of current ARARs that will be considered during the corrective action portion of the five-year review:

Landfill Cap:

- Act 641 - Michigan Solid Waste Management Act
- Act 347 - Michigan Soil Erosion & Sedimentation Act
- Michigan Compiled Laws Annotated Section 257.722 (Frost Laws)

Groundwater Treatment System:

- Safe Drinking Water Act (40 CFR141)
- Clean Air Act
- Michigan Air Pollution Act (Act 348)

VIII. SCHEDULE FOR CORRECTIVE MEASURES

The MDEQ has contracted with ABB Environmental Services, Inc., to begin design activities on the groundwater treatment system, repair the gas vents, conduct the slug tests and continue with groundwater monitoring activities. The groundwater treatment system. is expected to be completed in the Fall of 1997.

IX. NEXT REVIEW

Hazardous substances, pollutants or contaminants will remain at the Gratiot County Landfill site which will not allow for unlimited use or unrestricted exposure. The MDEQ will conduct another five-year review by September 2002. The review will be a Level I Review, consisting of a review of all recent groundwater monitoring and treatment data and newly promulgated environmental laws.

Site Review And Update

GRATIOT COUNTY LANDFILL

ST. LOUIS, GRATIOT COUNTY, MICHIGAN

CERCLIS NO. MID980506281

AUGUST 29, 1994

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Site Review and Update: A Note of Explanation

The purpose of the Site Review and Update is to discuss the current status of a hazardous waste site and to identify future ATSDR activities planned for the site. The SRU is generally reserved to update activities for those sites for which public health assessments have been previously prepared (it is not intended to be an addendum to a public health assessment). The SRU, in conjunction with the ATSDR Site Ranking Scheme, will be used to determine relative priorities for future ATSDR public health actions.

SITE REVIEW AND UPDATE

GRATIOT COUNTY LANDFILL

ST. LOUIS, GRATIOT COUNTY, MICHIGAN

CERCLIS NO. MID980506281

Prepared by

Michigan Department of Public Health (MDPH)
Under a Cooperative Agreement with
Agency for Toxic Substances and Disease Registry (ATSDR)

SUMMARY OF BACKGROUND AND HISTORY

The Gratiot County Landfill site was placed on the United States Environmental Protection Agency (U.S. EPA) National Priorities List (NPL) on September 8, 1983.

The Gratiot County Landfill site covers approximately 80 acres in the northwest corner of Jackson Road and Croswell Road, southeast of St. Louis in Gratiot County, Michigan (Figure 1). The site is approximately rectangular, 0.5 miles east-to-west by 0.25 miles north-to-south, occupying the southern 1/2 of the southeast 1/4 of Section 30, T12N, R2W (Bethany Township). There are two other sites on the NPL located approximately 2 miles northwest of the site (on the northwest side of St. Louis) — the Velsicol Chemical (Michigan) and Gratiot County Golf Course sites. The Alma Iron and Metal (Smith Farm) site, on the List of Michigan Sites of Environmental Contamination compiled under the Michigan Environmental Response Act, Public Act 307 of 1982 (Act 307), is located approximately 0.5 miles west of the Landfill. The Smith Farm site is on the Act 307 list because of lead, chromium, PCB, nickel, and PBB contamination.

Gratiot County operated a municipal landfill, that accepted domestic, commercial, and industrial waste, on the western half (40 acres) of the site from 1970 through 1976. In 1976, the U.S. EPA and the Michigan Department of Natural Resources (MDNR) were informed that the Michigan Chemical Company (later purchased by Velsicol Chemical Corporation) of St. Louis had disposed of 269,000 pounds of wastes containing 60 to 70 percent polybrominated biphenyls (PBBs) in the landfill between 1971 and 1973. A series of environmental studies found PBBs and other contaminants in the ground water and other environmental media on and near the site.

In 1973, a PBB-based fire retardant, manufactured by the Michigan Chemical Company, was mistaken for a magnesium oxide animal food supplement and sold to the Michigan Farm Bureau. The improper feed mixture was then widely distributed throughout Michigan. Tens of thousands of livestock, including cattle, chickens, and eggs, had to be destroyed because of contamination with PBBs. It has been estimated that 90% of Michigan residents were exposed to PBBs in this incident (1). In 1976, the Michigan Department of Public Health (MDPH) began a long-term health study of approximately 4,500 people heavily exposed to PBBs, including workers in the chemical industry who handled PBBs and farmers whose animals consumed it. This study included approximately 200 residents of Gratiot County, the majority of whom were workers at the Michigan Chemical/Velsicol plant in St. Louis or family members of workers (2). In a Fall 1988 Newsletter, the MDPH reported that data on deaths, with cancer mentioned on the death certificate, for members of the study cohort from 1973 through 1985 showed a lower incidence of cancer for the study cohort than expected. Another section of the study reported that overall mortality rates were less than expected for the entire cohort in the period 1976-1985. Analysis of these death statistics by levels of PBB levels in the blood showed a slight excess in death rates for the cohort with higher PBB levels compared to the cohort with lower, however, adjusting for age and sex differences rendered the excess statistically insignificant (3).

On November 10, 1982, Velsicol, the U.S. EPA, and the MDNR signed a consent agreement, with Velsicol agreeing to finance remedial actions at their plant site in St. Louis, the Gratiot County Landfill, and the Gratiot County Golf Course (where wastes had also been disposed of). In 1984 and 1985, the MDNR, using financing provided by Velsicol under the consent agreement, constructed a containment system around the landfill, consisting of an underground slurry wall surrounding the landfill, a 5-foot-thick clay cap over it, and an 8-foot fence to restrict access. The remediation was intended to include a groundwater purge system, but the purge system was not completed and has never been used. A stormwater collection lagoon, which drains into an agricultural drain tile north of the site, was constructed on top of the cap in the northwest corner of the landfill. A five-acre evapo-transpiration bed was also constructed on top of the cap for use by the proposed, but never completed, purge system.

Anecdotal reports indicate that the slurry wall did not enclose all the wastes present on the site. For example, on the south side, there were wastes found closer to Jackson Road than the wall could be constructed without disrupting the road's right-of-way. Some of these wastes were excavated and transferred into the landfill interior.

In 1974, PBB-contaminated poultry had been buried on a farm across Jackson Road from the eastern half of the site. During the construction of the cap on the site in 1984, the contractors decided to move this burial into the landfill, while taking clay for the cap from the same field. They excavated approximately 20,000 cubic yards of wastes, including chickens, cattle, eggs, and feeding equipment, and soils from the field and reburied the wastes and soils in the landfill (4).

In 1990, a local farmer, with permission from the County and MDNR, planted 10,000 red pine and white spruce trees on the eastern half of the site, east of the landfill. MDPH staff saw some of these trees during a site visit on April 23, 1993. The farmer, who is also the caretaker for the site, said that the trees were growing well.

A contractor for the MDNR carried out a hydrogeological investigation of the landfill area between 1989 and 1992 to evaluate the effectiveness of the slurry wall (1). The hydrogeological investigation concluded that the slurry wall appeared to be ineffective in several places around the landfill. The ground water gradient was very flat, making it difficult to identify the flow direction, however, they determined that the ground water in the site area flowed to the southwest. The slurry wall did apparently divert ground-water flow around the landfill. The ground-water level in wells within the slurry wall was very slightly lower than that in wells outside the wall.

Hydrogeological studies conducted in preparation for the construction of the landfill in 1970 found a ground-water divide running northwest to southeast beneath the landfill site, with gradients to the northeast on the northeast side of the divide, and to the southwest on the southwest side. The geology of the site area consists primary of clay beds with interspersed sand lenses. The sand lenses are generally poorly connected, though the largest one found in

the 1989-92 hydrogeological study appears to extend across the site from northeast to southwest, in an old river channel in the underlying clay till (1). In the vicinity of the southwest corner of the landfill, they found a large sand lens that extends to a greater depth than the design depth of the slurry wall.

Previous ATSDR Involvement

In November 1982, the Center for Environmental Health (CEH) of the U.S. Centers for Disease Control (CDC) carried out a consultation evaluating a proposed PBB control strategy at the Gratiot County Landfill site. The consultation concluded that the proposed remedy, capping the landfill and adding a slurry wall, could be sufficient for protection of public health. However, they did not offer unqualified support for the plan because there had not been sufficient data provided for a complete evaluation of potential health implications, particularly with regard to other contaminants present. This consultation was reissued in 1988 by the ATSDR as a Health Assessment for the site (5).

CURRENT CONDITIONS OF SITE

As described above, the MDNR has installed a fence, cap, and slurry wall at the landfill since the 1982 CDC-CEH consultation that the ATSDR later adopted as a Health Assessment for the site. These actions were completed by 1987.

The center of the City of St. Louis (1990 population 3,828) is approximately 1.5 miles northwest of the site. The center of the City of Alma (1990 population 9,034) is approximately 4 miles southwest of the site. Bethany Township had a population of 1,814 in the 1990 Census. The population of Gratiot County as a whole in 1990 was approximately 93.4% non-Hispanic white, 3.7% Hispanic, 0.8% Black, 0.35% Native American, 0.25% Asian or Pacific Islander, and 1.5% other. Approximately 25% of the County population was under 18 years of age, 12.5% was 65 years or older (9).

A. Site Visits

On March 18, 1993, Brendan Boyle and John Filpus of the MDPH briefly visited the site. They drove past the site, noting the proximity of nearby residences and the site features. Boyle and Filpus returned to the site on April 23, 1993. They reviewed documents in the Gratiot County Branch of the Mid-Michigan District Health Department, toured the site with a local farmer who acts as caretaker of the site for the MDNR, and met with a Gratiot County Drain Commissioner.

At the site, the farmer pointed out a few of the trees he'd planted on the east half of the site. There were also several groves of mature trees on the eastern half of the site, especially around a pond. They drove the farmer's four-wheel-drive pickup onto the landfill itself, and around the perimeter, noting, again, the proximity of various residences to the site. The cap

was heavily grass-covered. There were a few signs of erosion of the cap, especially near the gate, probably from authorized vehicles entering the landfill and climbing the sidewalls to the top of the cap. The clay of the cap was soft due to recent rains, and the truck wheels dug deep ruts in the cap. The truck got stuck at one point, and they all walked back to where they'd left the MDPH personnel's car. Boyle and Filpus drove the caretaker to his home where he could fetch a tractor to retrieve the truck from atop the landfill.

The nearest residence to the Gratiot County Landfill site is across Jackson Road south of the site, approximately 80 feet from the landfill fence. There is a mobile home permanently parked approximately 200 feet west of the landfill fence, and a small orchard to the south of the mobile home. Residents of the site area use private wells for their household water. The City of St. Louis has a municipal water supply. The nearest municipal well to the Gratiot County Landfill is approximately 0.75 miles north of the landfill.

There is a meeting hall, with occasional overnight camping, off Jackson Road south of the Gratiot County Landfill site. The facility is set back from the road approximately 0.25 miles, and is supplied with water from a private well on their property. Their water has been tested on a quarterly basis by the local health department and no contamination has been detected. The latest sample was taken in May 1993. There is a church-run camp located approximately 2 miles northeast of the site.

B. New Environmental Data

On-Site Contamination

Ground Water

Water from monitoring wells within the landfill sampled by the MDNR in 1977 contained as much as 26 parts per billion (ppb) of PBBs. Water from wells outside the fill areas collected in the same investigation contained up to 4.4 ppb of PBBs (10).

During the hydrogeological investigation in November and December 1989, the contractor collected water samples from wells located on and near the landfill. In March and April 1992, the MDNR again collected water samples from selected monitoring wells on and adjacent to the landfill. The concentrations of contaminants of concern found are listed in Table 1 (taken from References 1 and 11). During the hydrogeological investigation, the samples were analyzed for volatile organic chemicals, polychlorinated biphenyls (PCBs), pesticides, and PBBs. The MDNR analysis also included base-neutral organic chemicals. The "In-Landfill" column in the Table lists concentrations found in wells drilled into the waste. Wells G13 and G16 (each a 3-well cluster) are located approximately 60 feet apart, with G16 inside the slurry wall and G13 outside. They are located near the southwest corner of the landfill, one area where the hydrogeological investigation concluded that the slurry wall might be allowing ground water to pass, and where the investigation found a sand lens that might extend deeper than the slurry wall. The G13 cluster are the only wells outside the

slurry wall where samples have consistently contained detectable concentrations of contaminants, including vinyl chloride 33 ppb, benzene 44 ppb, and 1,1 dichloroethane 30 ppb. No PBBs or DDTs were detected in recent water samples from wells outside the landfill.

Surface Water and Sediment

Water samples from the landfill drainage ditch collected in 1977 contained as much as 14 ppb of PBBs. Sediment samples from the ditch contained up to 17 parts per million (ppm) of PBBs (12).

Off-Site Contamination

Ground Water

MDPH files include records of regular sampling of private wells near the Gratiot County Landfill since 1978. However, the latest sampling on record (as of March 30, 1993) was in 1987. The wells sampled included one for the house across Jackson Road south of the site, one west of the site along Jackson Road, and one north of the site along Croswell Road. None of these wells have ever contained detectable levels of contaminants . The MDPH Division of Water Supply plans to resample these and any other private wells in the Landfill vicinity during July 1993 (13).

Soil

In 1979, the MDNR collected soil samples for PBB analysis along Jackson Road near the site. Samples collected adjacent to the site contained as much as 4,600 ppb of PBBs. Samples of surface soil from 0.5 miles west of the site, at the corner of Jackson and State Roads, contained as much as 2,400 ppb of PBBs (14). In 1980, the MDNR again collected surface soil samples adjacent to the site and to the southeast. The sample adjacent to the site contained 1,608 ppb of PBBs, and the PBB concentrations dropped sharply, to 8 ppb at the corner of Croswell and Jackson Road and below the 5 ppb detection limit 0.5 miles east of the site (15).

Surface Water and Sediment

In 1977, water from a catch basin and a wetland on property north of the landfill contained as much as 0.2 ppb PBBs. Sediment from near the catch basin, immediately north of the landfill, contained up to 1.2 ppm PBBs (12).

Biota

In 1980, the MDNR, on MDPH request, collected 42 wild animals (and birds) of eight species within a 1 mile radius of the Gratiot County Landfill site. Meat from the animals collected was analyzed for PBBs, polychlorinated biphenyls (PCBs), and various pesticides. The results of this analysis are listed in Table 2 (16). Because of the PBB levels found in these samples, on September 29, 1981, the MDPH issued an advisory that no one should eat any muskrat, raccoon, opossum, pheasant, or grouse taken within 2 miles of the landfill (17).

In 1980, meat from cattle being raised 0.5 miles southeast of the landfill contained up to 51 ppb of PBBs. This herd was fed on hay supplied by a farm across Jackson Road from the landfill, the same farm where the contaminated poultry had been buried in 1974, and the hay was found to contain as much as 42 ppb of PBBs. PBBs are not known to be readily taken up by plants from the soil, and the MDNR concluded that this contamination was probably the result of airborne transport of dust from the landfill. Testing of roadside vegetation near the site showed the presence of PBB, believed to reflect dust settling onto the leaves. The reference does not discuss the disposition the hay and cattle (18).

Alma Iron and Metal (Smith Farm) site

This property covers approximately 20 acres 0.5 miles west of the Gratiot County Landfill. In 1979, soon after the property was purchased, the new owner requested an investigation of the property by the MDNR. The property was littered with approximately 400 barrels, some intact and containing liquid or solid wastes, others had rusted through, and some had been crushed. Some of the barrels still bore legible labels from the Michigan Chemical Company and Alma Iron and Metal. The MDNR has estimated that the barrels had been disposed of on the site for approximately 15 years. The MDNR sampled the contents of the barrels, soil, sediments, sledges, and surface water from a pond on the east side of the property during November and December 1979, April and September 1985, and April 1987. The contents of the intact barrels contained various volatile organic chemicals (VOCs) and metals. Soils and sediments contained metals, PCBs, and PBBs. The surface water contained PCBs, PBBs, VOCs, semi-volatile organic chemicals, and metals (Table 3) (19). A private well on the property has been sampled and no contamination has been found in the water. The property is fenced with signs posted warning of the hazardous chemicals. The Potentially Responsible Parties (PRPs) for the Smith Farm property, under U.S. EPA direction, have removed some surface drums and other trash for disposal elsewhere. The PRPs, under direction from the MDNR and U.S. EPA, are evaluating the extent of contamination at the site in preparation for remediation.

In early 1980, chickens on the Smith Farm property were found to contain PBBs above State standards (the exact concentrations are not reported in the reference). The chickens were confiscated and destroyed (20).

CURRENT ISSUES

Once it became public knowledge that PBBs had been disposed of in the landfill, community members voiced their concerns regarding the landfill. Local health department staff have characterized the concerns as reflecting worries about exposure to the contaminants and the potential health impact from the exposure. They do not recall any specific citations of adverse health effects (6). The greatest amount of citizen involvement and concern occurred between 1976 and 1985, when the contamination was first reported and while the cap and slurry wall were being installed. The local health department has not heard any citizen concerns expressed since 1987 (7, 8).

According to a Gratiot County Drain Commissioner, the greatest concern voiced recently by the residents of the site area is that the aftermath of the PBB incident has adversely affected the values of their property (21).

CONCLUSIONS

The Gratiot County Landfill site poses no apparent health hazard at this time. There is a potential for human exposure to chemicals at levels of possible health concern, via contaminated ground water seeping through or under the slurry wall. No contamination has been found in nearby residential wells to date. Available hydrogeological information indicates that site-related contaminants are not likely to reach nearby residential wells, though the possibility cannot be eliminated.

At this time there is no apparent need for a further health assessment, consultation, or study related to this site.

RECOMMENDATIONS

A. Status of ATSDR Recommendations

The 1982 CDC-CEH consultation that the ATSDR adopted as a Health Assessment for the Gratiot Landfill site (Reference 5) cited many data gaps in the document reviewed, "Technical Report 8204, Options and Recommendations for a Polybromobiphenyl (PBB) Control Strategy at the Gratiot County, Michigan Landfill," as follows:

> "Actual risk of exposure cannot be determined until ... additional environmental information is obtained on the distribution of contaminated soils in the vicinity of the landfill from wind erosion, on the levels found in the sediment of the receiving stream and in aquatic organisms (benthos and fish), on the levels, extent, and dispersion rate of the contamination in the affected upper aquifer, and in the groundwaters above the protective clay layer."
>
> "With regard to the groundwater levels found ranging from zero to 26.0 ppb [of PBB] during a 15-month period, no information is provided on the location of the stations and the relative distance to any potential users of the affected aquifer."
>
> "The Technical Report fails to discuss any local surface water uses."
>
> "Probably one of the most significant failings of the Technical Report is the lack of consideration to [*sic*] other pollutants (arsenic, lead, chromium, cyanide, phenol, cadmium, etc.) which supposedly exist in the landfill and which were described in the SIG [Superfund Implementation Group, presumably] package. No assessment of the concentrated [*sic*, presumably for concentration] distribution the potential risk of exposure has been provided for these contaminants."
>
> "In summary, the proposal ... does not address other contaminants [besides PBBs] nor the disposition of PBB contaminated areas off-site from the landfill.... little or no information is presented and/or known about the existing populations at risk and the distribution of PBB's and other contaminants in the area ... Detailed geohydrologic information and exhibits should have been provided ..."

The recent hydrogeological study fulfills at. least part of these recommendations by providing detailed geohydrologic information and using analyses for a full range of chemical contaminants besides PBBs (1). Soil sampling studies dating even before the CDC review found PBB contamination far beyond the site boundaries, affecting a large area of Gratiot County (14, 15). The MDNR and other agencies dealing with the PBB problem did not chose to address the broad question of PBBs in the soil and sediments, because of the

magnitude of the clean-up project that would have been required. The agencies sought to prevent further contamination by containing the PBBs within the landfill. Any adverse health effects from the remaining regional contamination would be addressed by the long-term PBB health study. The questions of transportation of contamination through fugitive dust, surface water use, and others have not been addressed, though the remediation has rendered them relatively moot at this point.

B. New Recommendations

1. Residential wells near the site should be monitored regularly.

2. Appropriate remedial actions to reduce or prevent the passage of ground water into and through the landfill should be investigated.

C. Health Activities Recommendation Panel Statement

A Health Activities Recommendation Panel convened by ATSDR and MDPH has evaluated the data and information developed for the Gratiot County Landfill Site Review and Update for appropriate follow-up actions. The panel determined that there is evidence of past exposure to PBBs associated with this site, during the Michigan PBBs incident. As the MDPH is conducting a long-term study of people exposed to PBB and providing community health education as part of the study, no additional health actions are needed at this time.

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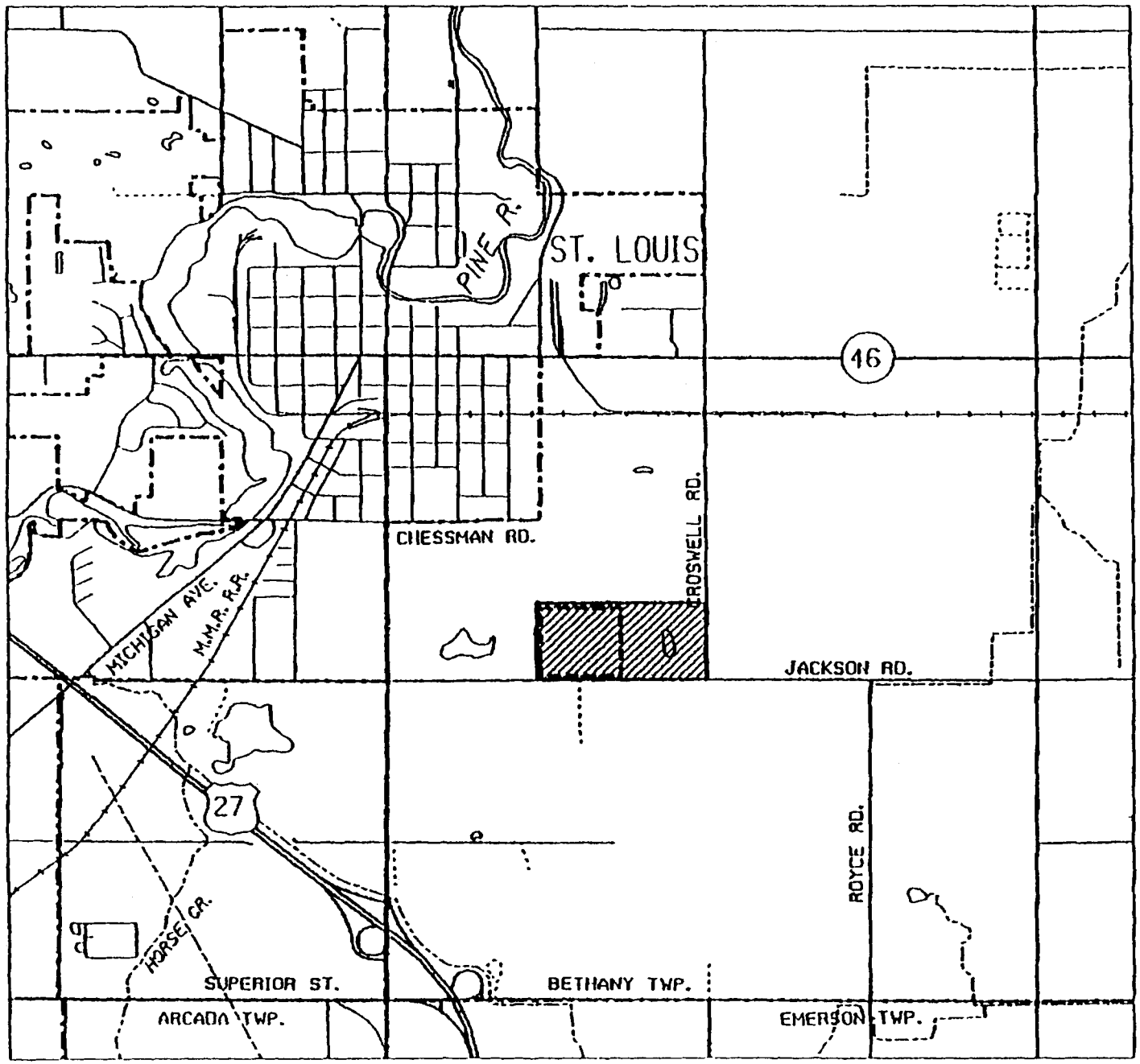
APPENDIX A.

FIGURES

LIST OF FIGURES

Figure 1. Site Location

Figure 1.



GRATIOT COUNTY LANDFILL

SITE LOCATION

- INTERSTATE HIGHWAYS (196)
- U.S. HIGHWAYS (2)
- STATE HIGHWAYS (55)
- OTHER MAJOR ROADS
- MINOR ROADS
- TWO-TRACK ROADS
- AIRPORTS
- GRASS AIRSTRIPS
- RAILROADS
- ABANDONED RAILROADS
- RIVERS AND STREAMS
- INTERMITTENT STREAMS
- POLITICAL BOUNDARIES
- SUPERFUND SITE
- LANDFILL

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MILES

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Michigan Department of Public Health

Base map information provided by Michigan Department of Natural Resources, MIRIS Program

6/28/93

APPENDIX B.

TABLES

LIST OF TABLES

Table 1. Concentrations of chemicals of concern in ground water at and near the Gratiot County Landfill, November-December 1989, March-April 1992 . . . . . B-3

Table 2. Maximum concentrations of PBBs, PCBs, and pesticides found in wildlife collected near the Gratiot County Landfill in 1980 . . . . . B-5

Table 3. Summary of chemicals found in samples from the Alma Iron and Metal (Smith Farm) Property, 1979-1987 . . . . . B-6

Table 1. Concentrations of chemicals of concern in ground water at and near the Gratiot County Landfill, November-December 1989, March-April 1992

Chemical	Date	In-Landfill (ppb)	G16 (ppb)	G13 (ppb)	Reference	Comparison Value (ppb)
aldrin	1989	ND	ND	ND	1	0.002[C]
	1992	8.2	ND	ND	11	
benzene	1989	100	300.E	44	1	1[C]
	1992	55	130	27	11	
benzo(a)anthracene	1992	10	ND	ND	11	NA[C]
benzo(a)pyrene	1992	9	ND	ND	11	0.005[C]
benzo(b)fluorathene	1992	9.1	ND	ND	11	NA[C]
benzo(g,h,i)perylene	1992	4.4	ND	ND	11	NA
benzo(k)fluorathene	1992	6.3	ND	ND	11	NA[C]
bis(2-ethylhexyl)phthalate	1992	35	ND	ND	11	3[C]
chloroethane	1989	8.J	24	12	1	NA
	1992	ND	ND	8.9	11	
chrysene	1992	11	ND	ND	11	NA[C]
4,4'-DDD	1989	ND	ND	ND	1	0.1[C]
	1992	0.035	ND	ND	11	
4,4'-DDE	1989	ND	ND	ND	1	0.1[C]
	1992	0.065	ND	ND	11	
4,4-DDT	1989	ND	ND	ND	1	0.1[C]
	1992	0.16	ND	ND	11	
di-n-octyl phthalate	1992	3.4	ND	ND	11	NA
dibenzo(a,h)anthracene	1992	0.73	ND	ND	11	NA[C]
1,4-dichlorobenzene	1992	8	ND	ND	11	NA[C]
1,1-dichloroethane	1989	ND	16	30	1	NA[C]
	1992	6.2	13	18	11	
1,2-dichloroethane	1989	ND	ND	ND	1	0.4[C]
	1992	ND	8.4	14	11	
dieldrin	1989	ND	ND	ND	1	0.5[E], 0.002[C]
	1992	0.11	ND	ND	11	
indeno(1,2,3-c,d)pyrene	1992	4.7	ND	ND	11	NA[C]
naphthalene	1992	23	ND	ND	11	20[A]
PBBs	1989	ND	ND	ND	1	NA[C]
	1992	3.2	ND	ND	11	
PCBs	1989	ND	ND	ND	1	0.05[E], 0.005[C]
	1992	2.1	ND	ND	11	
phenanthrene	1992	48	ND	ND	11	NA
vinyl chloride	1989	ND	ND	ND	1	0.2[E], NA[C]
	1992	ND	ND	33	11	

E – Estimated Value, above calibration limit
J – Estimated Value, below quantfication limit
ND – Not Detected
NA – Not Available
NA[C] – Carcinogen (proven, probable or possible) but CREG Not Available

Comparison Value Bases:

A – U.S. EPA Drinking Water Health Advisory (Lifetime)
C – ATSDR Cancer Risk Evaluation Guide (CREG)
E – ATSDR Environmental Media Evaluation Guide (EMEG)
R – Concentration calculated from U.S. EPA Reference Doze (Chronic), assuming child consumption

Table 2. Maximum concentrations of PBBs, PCBs, and pesticides found in wildlife collected near the Gratiot County Landfill in 1980.

Species	# Sampled	PBB		PCB		DDT		DDE		Dieldrin	
		#	(ppm)	#	(ppm)	#	(ppm)	#	(ppm)	#	(ppm)
Rabbit	22	1	Trace	0	ND	0	ND	2	0.01	0	ND
Muskrat	6	6	1.51	1	0.06	1	0.01	2	0.01	0	ND
Raccoon	2	2	3.77	0	ND	0	ND	1	0.05	1	0.01
Deer	4	1	Trace	0	ND	0	ND	2	Trace	0	ND
Opossum	5	5	2.08	2	1.58	0	ND	4	1.67	3	0.02
Squirrel	1	0	ND	0	ND	0	ND	0	ND	0	ND
Pheasant	1	1	0.05	0	ND	0	ND	1	0.04	0	ND
Grouse	1	1	0.03	0	ND	0	ND	1	0.03	0	ND

Reference: 16

Concentrations an a dry weight basis, of an edible portion.

– Number of positive detections for the chemical
ND – Not Detected

Table 3. Summary of chemicals found in sample from the Alma Iron and Metal (Smith Farm) Property, 1979-1987

Chemical	Soil/Sediment (ppm)	Drum Contents (ppm)	Sludge (ppm)	Surface Water (ppm)
Arsenic	28	2.5	8	ND
Cadmium	19	5	13	ND
Cobalt	12	ND	ND	ND
Chromium	470	93	25	ND
Copper	9,700	7,100	1,700	510
Iron	117	51,000	16,000	33,000
Mercury	7.5	ND	ND	ND
Manganese	3.6	ND	ND	440
Nickel	450	2,530	4,600	55
Lead	11.3	10,000	307	745
Zinc	9,850	36,000	95,000	710
PCBs	5.1	ND	NR	26,000
PBBs	0.038	ND	NR	0.3
Hexachlorobenzene	0.28	ND	NR	ND
4,4'-DDE	0.17	ND	NR	ND
1,2,4-Trichlorobenzene	ND	ND	NR	0.01
Diethylphthalate	ND	ND	NR	6.4
Bis(2-ethylhexyl)phthalate	ND	ND	NR	97
1,2-Dichloroethylene (total)	ND	ND	NR	12
Toluene	ND	ND	NR	24,000
Ethylbenzene	ND	ND	NR	1,000

Reference: 19

Maximum concentrations detected listed

ND – Not Detected
NR – Sludge Samples Not Analyzed for Organic Chemicals
NQ – Present in Samples, but Not Quantified

Other Chemicals Present but Not Ouantified in Drum Contents Samples:

1.3-Dichoropropene
Methylene Chloride
Tetrachloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Xylene